DECEMBER 1960

Soil Conservation

SOIL CONSERVATION SERVICE • U. S. DEPARTMENT OF AGRICULTURE

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"Two hundred generations of men and women have given us what is in our minds about soils and soil fertility—the arts and skills and the organized body of knowledge that we now call soil science."
—Charles E. Kellogg

COVER PICTURE.—A soil surveyor at work in Montgomery County, Maryland.

Soil Conservation

EZRA TAFT BENSON
Secretary of Agriculture

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Administrator, Soil Conservation Service

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TOM DALE, Editor

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Soils—The Key to Proper Land Use

By Donald A. Williams

OUR soil and water conservation program must begin with the soils. The soils determine, to a large extent, the productivity and potential productivity of all tracts of land. Furthermore, most of our water problems are tied closely to the soils of the areas where the problems exist.

I have consciously used the word "soils" to emphasize that we have a great many kinds—probably 70,000 or more in the United States alone. Each of these has a unique set of characteristics, unique history of formation, and many of them a different pattern of potential behavior.

Some soils are suited to only one use; but most soils used by farmers can be treated successfully in several different ways. One of our principal jobs in assisting cooperators in soil conservation districts and other land users is to explain just what these different ways are. We must warn specifically against systems of use that allow soils to deteriorate. We must explain systems that will help conserve and build up soils to assure greater permanent productivity.

In helping land users, we must show them what kinds of soil they have on their farms and ranches and how these soils respond to various types of use and treatment. For this a soil survey is essential. A good farm or ranch plan begins with a soil map and up-to-date knowledge of how the soils shown on the map behave.

One of the first objectives of our soil survey is to have the many different kinds of soil uniformly named in a national system, so that the same kinds of soil everywhere are given the same name. We can assemble and classify results of research and of farmer experience with different kinds of soil only if the soils are uniformly defined and named.

A system of land use that gives good results on one kind of soil may give very bad results on another kind, even on the same farm. Through soil classification, and its interpretation in light of our current research and experience, we can suggest up-to-date alternative uses for the various kinds of soil. We can and do group many of the different soils into what we call capability units whereby all soils of the unit have similar risks and limitations for cropland agriculture and hence may be used and treated in much the same way. Then, for general planning, we group the capability units into capability subclasses, and capability classes. With this system of classification we can readily determine from a soil map precisely which uses and treatments are adapted to any given field.

Thus our soil survey—soil map and descriptions and interpretations of the soils—serves as a bridge between our great body of soil science and technology, on the one side, and the individual fields and farms, on the other. We are able to apply modern soil science and technology to specific situations with accuracy and dispatch.

The farmer or rancher must make the final decisions as to the uses and treatments applied to the land he operates. But it is the duty and responsibility of SCS technicians to point out the acceptable alternative uses and recommend the combinations of treatments compatible with the science of soil and water conservation. Then landowners can be assured that the system selected is always within the capability of the soils and is conducive to soil improvement and good water management.

Besides helping to select productive, conserving systems for farms, soil surveys also help to guide the management of ranches and forests. They serve engineers who build airports, highways, housing developments, and other structures on various kinds of soil. They provide a firm basis for the most effective planting and managing of "greenbelts" around and between our cities—areas that can avoid the evils of either urban or rural slums.

We hope and we believe that our present soil surveys are accepted by nearly everyone as non-controversial, objective assemblies of scientific facts. Of course, we expect that people will interpret some of these facts differently. Though new technology is continually changing the relative value of some of our soils for different uses, the Service will continue to try to guide people to select uses for their soils that will permit those soils to be maintained and improved.

Soil Surveys Furnish Basic Data For All Land Uses

By Roy D. Hockensmith

SOILS differ from one another just as people differ. Some have a high potential for production, while others have varying degrees of limitations. Some of these limitations can be corrected; we simply have to recognize and live with others.

In making soil surveys, soil scientists determine the characteristics of soils by both field and laboratory studies. They determine the thickness of the soil, its texture, structure, color, and acidity or alkalinity. They also study other characteristics, especially those having to do with the behavior and potential productivity of the soil as a whole, such as slope of the soil surface, significant losses by erosion, stoniness, salt accumulation, and evidences of imperfect drainage or flooding. From a study of these many characteristics the soils are classified and named. Each kind is indicated by an appropriate symbol on the map and in legends.

From these observations, supplemented in some instances by laboratory studies, they estimate permeability of the soil, erosion hazard, and other qualities important to the use of each kind of soil.

While making a survey, the soil scientist collects soil samples by soil horizons to be studied in the laboratory. For most analyses loose samples of about a gallon from each horizon are satisfactory.

In the laboratory a scientist measures particle-size distribution to help estimate the water-holding capacity. He measures the rate that water moves through the soil. He studies samples of soil to learn the distribution of certain important minerals.

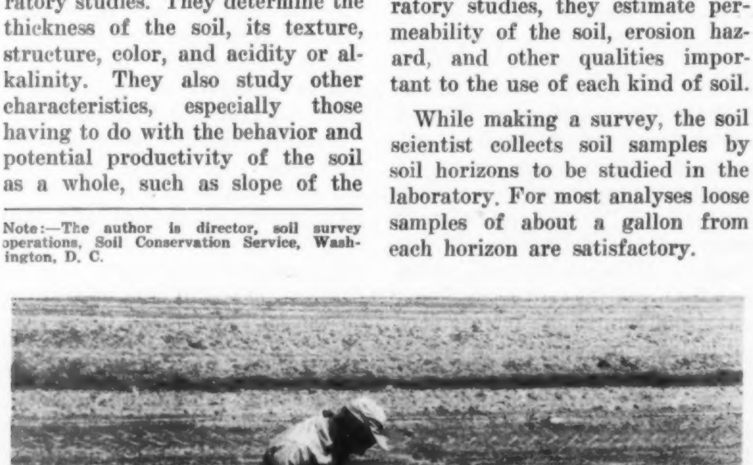
These laboratory studies make it possible to use the information available on one soil for predictions about other soils with similar characteristics and qualities. At the same time they reveal information that helps in using all the soil information. For example, tests on water-holding capacity may open up new possibilities for the irrigator; or the rate of water movement through the soil may help in planning a tile drainage system.

Where information is needed for highway construction or other engineering uses, 30-pound samples are taken. These provide enough soil for mechanical analyses and other tests to determine engineering properties of the soil.

To give technical soil assistance for some purposes, such as designing drainage systems, deep borings must be made. Checking foundation material on which to build heavy structures or highways and checking the porosity of deep layers that may cause a pond to leak are other examples of special purpose determinations.

To extend information obtained on one soil to similar soils in other areas requires soil correlation. One of the immediate purposes of soil correlation is to assign names to

Note:—The author is director, soil survey operations, Soil Conservation Service, Washington, D. C.



A hole dug with a spade permits the soil surveyor to study the undisturbed soil profile.

the soil units shown on the maps. These, of course, must be consistent with and fit into the nationwide system of soil classification; that is, the name of a soil in a given area must be the same as for soils in other areas that do not differ importantly in properties significant to its genesis and use.

Information about how soils respond to different kinds of management and treatment is gathered from many sources. Farmers' experiences and field trials provide much information. More precise information is gained by experiment stations and other laboratory and field experiments where tests are made under controlled conditions. As information is collected on one soil or on a group of related soils, it can be projected to other similar soils.

Because there are so many kinds of soils and problems, many kinds of soil interpretations are needed. Most users of soil surveys also want more general information than that given about the individual mapping units. They like to have soils that behave alike in response to management and treatment for specific uses grouped together. By introducing the reader to the map, such groupings result in wider and more efficient use of most surveys.

The land-capability classification is one interpretative grouping. It helps to introduce agricultural users to the detailed soil map. Soils are grouped according to their adaptability for common farm crops under permanent agriculture, to what they can be expected to do, to their limitations for sustained production, and to the risk of soil damage if they are mismanaged.

In this classification the individual mapping units are first grouped into capability units. The soils in any one capability unit have similar risks and limitations for agricultural use, respond to the same broadly defined practices, are adapted to about the same farm

Soil samples are taken for laboratory testing.

crops, and return about the same yields under comparable systems of management. Thus, the capability unit is a basic management unit for common farm crops.

Capability units are grouped into capability subclasses, a grouping that suggests both the degree and the kind of problems that a farmer or rancher will encounter in longtime use of the soil.

Capability subclasses, in turn, are grouped into capability classes, a grouping that expresses only the degree of limitation and risk for agricultural use.

This interpretation is widely used in giving technical assistance to farmers and ranchers through soil conservation districts. Soils are also grouped for special crops, for range sites, and for woodland suitability.

Although most people dealing with land may use soil surveys, the primary use of soil surveys is to help farmers plan their operations. Soil surveys are used particularly by technical people and others who advise and give farmers technical assistance.

With a soil and capability map of his land, a farmer has the opportunity to add greatly to his own knowledge about his soils. A soil conservationist uses the soil map to help him make a conservation plan.

Laboratory testing is done to determine the clay content and other characteristics of soils that are not readily determined by field studies.

Let's take, for example, the 26-acre area on the farm illustrated below. This area consists of two soils that have been given symbols 30C2 and 36C2. Both occur on C slopes (6 to 12 percent) with moderate erosion. The soils, Downs silt loam and Fayette silt loam, are well drained and water moves through them easily. Downs silt loam was developed under mixed grass and tree vegetation; the Fayette silt loam was developed under forests. The Downs silt loam is slightly higher in organic matter and a trifle more fertile. It has a thicker surface soil and a slightly more friable subsoil than Fayette silt loam. But the soils are enough alike for most agricultural purposes that they belong in the same capability unit. They are suitable for growing all field crops common in the area. Since the soils can be used safely for cropland with appropriate conservation practices, they are placed in capability Class III. These soils have high potentials for crops if runoff is controlled and soil fertility maintained.

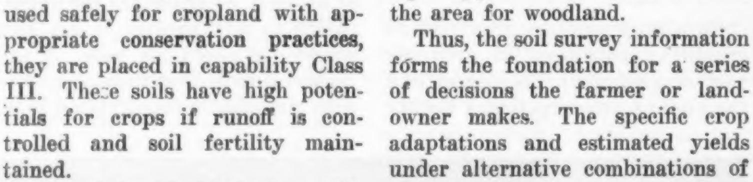
If used for cropland, these soils can be managed in several ways. With no special conservation practices other than maintaining adequate fertility, a four-year rotation of small grain and three years of hay could be used. If tilled on the contour, a year of corn can be included and a five-year rotation of corn, grain, and three years of hay would suit. Stripcropping permits using a three-year rotation of corn, grain, and hay. Terracing permits a five-year rotation of corn, corn, grain, and two years of meadow. Any of these combinations would control runoff and hold soil loss from erosion down to less than four tons per acre per year, an allowable loss for these soils.

Other alternatives may be considered. If the farmer wants to use this field for pasture, he can choose from two or more kinds of pasture management, depending on how they suit his needs. The same principle applies if he decides to use the area for woodland.

Thus, the soil survey information forms the foundation for a series of decisions the farmer or landowner makes. The specific crop adaptations and estimated yields under alternative combinations of practices give him the basis for a decision. Then alternative ways of managing and protecting the soil while in any chosen use are pointed out.

The farmer may then make a choice based on his preferences, needs, and how the use for this area fits in with the use and management of the entire farm or ranch. When this procedure has been carried out for all the different soils on the farm, and the uses of each related to the whole economic unit, a conservation farm plan has been made.

The potential capabilities of most range sites are determined by the soils.



There are 5 different soil mapping units on this farm, but the 2 mapping units at the left fall in the same capability unit, IIIe[1].

Soil information also is valuable to the rancher. Soils are grouped into range sites. For example, deep, well-drained soils located in valleys are often the best for production of range grasses, and thus are grouped together for ranch management purposes as valley range sites. Deep upland soils are grouped together as deep upland range sites. Shallow upland range sites include soils that are shallow and somewhat droughty, and so on.

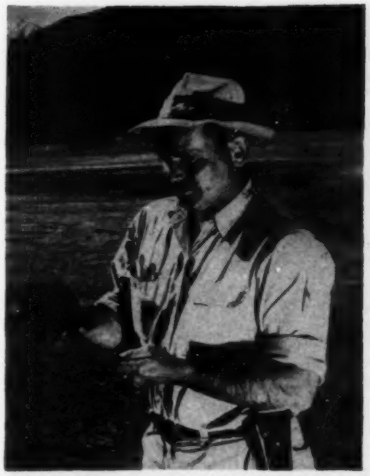
Land appraisers have found that soil surveys are useful not only to estimate land values for individual tracts, but also to provide common standards for an area. For example, the tax assessor for Polk County, Iowa, revised the tax base

in 1952 after a soil survey for the entire county had been completed and interpreted. The county shared the cost of the mapping in order to speed up the work.

Since corn is the main crop in Polk County, it was decided that corn production would be used as the basis for determining a value for each tract of land. Soil survey information was translated into earning power through a system of corn suitability ratings. Iowa State University and USDA scientists helped develop "corn suitability ratings" based on known performance of the different soils. Ten grades of corn suitability ratings were established. Muscatine silt loam, for example, produces 60 bushels of corn per acre with average management and was given a grade of 1. Thurman Sand produces about 25 bushels with the same level of intensity of management (although a somewhat different combination of practices is suited to the soil) and was given a grade of 8. Other soils were rated in the same manner. Every tract of 40 acres was given a grade. These grades were given according to output (harvest) over input (materials and labor), with average or normal management for the soil.

The assessor of Polk County reports that he had only one protest from a farmer taxpayer in 1954 (based on 1953 assessment), and it concerned the buildings. In 1949, under the old system, more than 1,500 protests were filed by farmers. Many other counties also have used soil surveys in appraising land for tax assessment.

County and community planning officials are finding soil surveys of increasing value in helping to deal with the so-called "Urban Sprawl." Soil surveys show the areas which are most productive for agricultural products and thus may be needed in the future for a fast-growing population. They



Soil texture is determined largely by feel to an experienced soil surveyor.

show areas that are less desirable for agriculture but may be just as suitable for houses, schools, supermarkets, parking lots, and industry. With this kind of information, planning officials can help direct non-agricultural expansion onto less productive lands and thus help protect the food production base.

Soil surveys are being used increasingly for planning urban and suburban areas. The engineering interpretations dealing with the suitability of the soils for use in and support of roads, buildings, and other structures and for absorbing effluent from septic tanks are becoming more widely used.

Where soils are evaluated as foundations for structures, their texture, compactness, and moisture content are of outstanding importance. The position of the ground water table and depth to rock likewise cannot be overlooked.

The first step in designing subsurface sewage-disposal systems is to determine whether the soil will absorb septic tank effluent readily and, if so, how much area is required.

Because of the nature of his work, the engineer needs information not only about the soil, as the soil scientist knows it, but also about the material that lies below the soil. Actually, to many engineers "soil" includes all the unconsolidated material that may be moved by earthmoving equipment and usually extends from the

A 42-inch power probe, mounted on a light truck, is used to get undisturbed soil samples rapidly. The open "window" of the probe permits the soil surveyor to check texture, structure, consistence, and color of any part of the profile.

Soil maps and descriptions were used to find out about the soils and underlying material in constructing the Kansas Turnpike.

surface to bedrock. Where the depth to bedrock is more than about 6 feet, the engineer ordinarily finds the information in most soil surveys quite general, but even such general information frequently is useful.

Engineers need such information about soils as grain-size distribution, water-holding capacity, water intake rate, optimum moisture content, maximum dry density, liquid limit, plastic limit, plasticity index, shrink-swell potential, depth to rock, wetness, and drainability. They also need to know the erodibility of soils in order to plan safe water disposal along a highway. And they need to know about growing grass on banks and fills.

While engineers make use of the soil scientists' classification of soils, they have also developed their own systems for classifying soil materials. Their systems are oriented exclusively for construction purposes. Two are used rather widely. In both of these, the soil materials are classified on the basis of three properties—grain-size distribution, liquid limit, and plasticity index. These properties are now known or can be estimated for soil layers in profiles representative of many of the soil scientists' soil types. By indicating what the soils are, layer by layer, in each of the engineering systems, more engineers are making better use of the soil scientists' soil surveys.

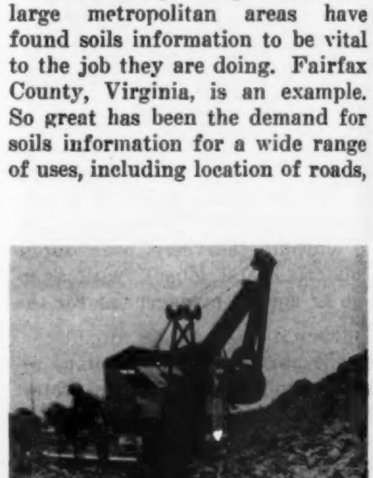
The conservation engineer also has many uses for soils information. For example, he needs to know how fast water enters the soil (intake rate) and how rapidly water passes through the soil. He needs such information in order to lay out terraces, irrigation and drainage systems, and to determine the size of flood-retarding dams.

Foresters and woodland conservationists are learning a great deal about the relationships between different kinds of soil and woodcrop production, as well as related soil-use values, such as for watersheds, recreation, and wildlife. This information is especially useful when the relationships of the different soils are presented by grouping the soils that behave alike in response to management and treatment for specified woodcrops. In the newer soil survey reports these are presented as Woodland Suitability Groupings. Each such soil grouping is evaluated for different items of use and management so as to give "leads" to the choice of adapted species, information about potential productivity, and the best combination of conservation practices needed. Soil conservationists and other technical personnel use this information in giving assistance to woodland owners or operators.

Wildlife conservationists find soil surveys helpful in planning and developing measures for protection and improvement of wildlife habitat. Some soils are well suited to this use but to no other. A survey may be used for evaluating habitat, locating and building ponds and dugouts for waterfowl, and in locating recreation, hunting, and fishing sites.

Other groups representing a variety of interests need information that soil surveys provide. The Soil Conservation Service and State agricultural experiment stations give this kind of help where possible and encourage the groups themselves to employ soil scientists to help with this kind of work.

In recent years planners for large metropolitan areas have found soils information to be vital to the job they are doing. Fairfax County, Virginia, is an example. So great has been the demand for soils information for a wide range of uses, including location of roads,



Oil and gas companies use soil surveys to determine routes of pipelines.

septic tanks, shopping centers, schools, foundations for large buildings, underground utilities, and other uses, that the county supervisors appropriated money to help complete the soil survey and hired a soil scientist to work with local people. The soil scientist devotes all his time to interpreting the soil survey for the various government agencies and citizens of the county.

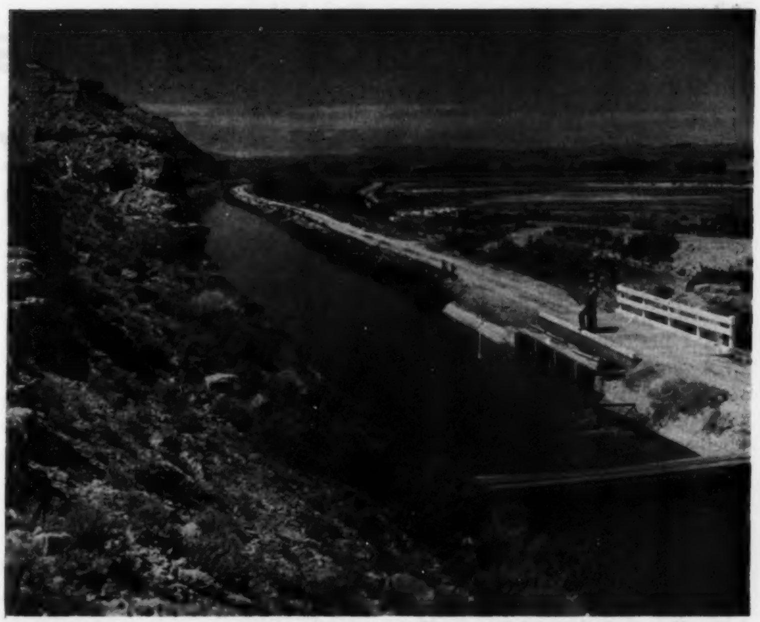
Oil and gas companies use soil surveys to plan the routes of pipelines where corrosion will be least and to plan for erosion control after they are installed.

One gas company in Nebraska has been working with soil scientists for over 20 years. They not only got information that helped them in locating the line but also encouraged many farmers to practice soil conservation where the pipelines were endangered by erosion. Telephone and power companies who lay underground lines have similar need for soil information, especially on the depth to rock.

Food processors and canneries want to locate their plants where they can be assured of a reliable source of raw materials. Is there enough land with soils suitable for growing tobacco, sweet corn, peas, strawberries, tomatoes, or soybeans? Soil facts help provide the answers.

Investors, banks, insurance companies, and building and loan companies find soil surveys helpful in determining the soundness of proposed investments in land. Manufacturers of earthmoving equipment need soils information in the design of certain types of machinery.

Various soil conservation, watershed conservancy, and drainage districts have need for soils information in making district plans and in developing district programs. A detailed soil survey actually forms the foundation for a soil conservation district's program of work by showing where the most urgent work is needed and what kind of program will be most beneficial.



Soils information was used in designing this irrigation canal, especially to determine which sections should be lined.

Although many of the ordinary uses of soil surveys are also found in watershed activities, some of the uses peculiar to watershed work are: (1) They serve as a basis for the delineation of plant-soil groupings which the hydrologist uses to estimate rates and amounts of storm runoff; (2) they provide one of the bases for computing sedimentation rates, rates of delivery, trap efficiencies of reservoirs, etc.; and (3) they serve as a basis for estimating the suitability and productivity of the floodplain when flood protection and drainage are provided.

Research workers in experiment stations use soils information to set up crop and fertilizer studies. Extension workers and teachers use soil maps to help show farmers and students how to do a better job of farming.

The findings of a soil survey are published as a soil map and a printed text that describes each of the soils, summarizes what is known about them, and explains their potential uses.

Most of the present reports are written primarily for agricultural users of the map. Most of them include additional information of value to engineers, foresters, geologists, land appraisers, and others. Since they report basic soils information, other interpretations for specific purposes can be made from them.

If the units on the map are properly described, the survey can be interpreted and reinterpreted as economic or other conditions change. Since yield predictions and management recommendations from a soil survey depend upon both the soil and the state of the agricultural arts, the development of new technology usually requires new interpretations.

A Realtor's Views About Soil Surveys

By Verlin W. Smith

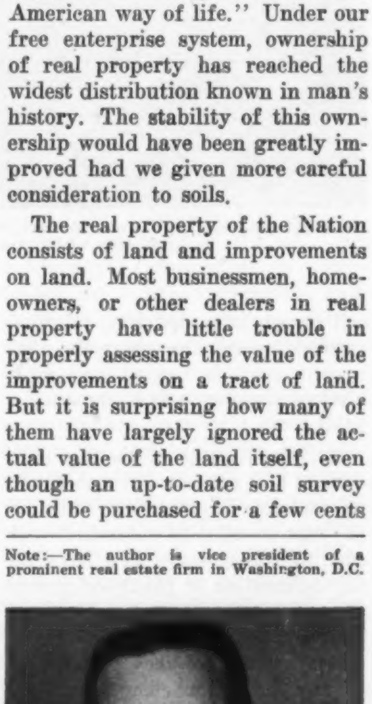
MY first contact with a soil survey party was in July 1949, while seeking information about a farm in Loudoun County, Virginia. That was the beginning of my practical education about the use of soils maps in the real estate business, whether it be a farm, rurban acreage, suburban housing development, or individual homesite that is involved.

Previously, I had received a B.S. degree in agriculture from the University of Maryland, with agricultural education as a major. My course of study included many agricultural subjects, with some courses about soils. But it did not provide enough information about how soils information—and especially good soils maps—may be profitably used by nearly all farmers, rurbanites, and urbanites. Since learning the importance of soils and the differences in the quality of soil maps, I have tried, in my professional capacity, to pass on this information to clients who buy or sell land. I also have spent a great deal of time trying to show professional colleagues the value of using good soil maps in their real estate transactions.

The general welfare of every taxpayer and freeholder is affected by his, his neighbors', or his government's improvements on the earth's surface. The preamble to the code of ethics of the National Association of Real Estate Boards states: "Under all is the land. Upon its wise utilization and widespread ownership depend the advancement of national well-being and the perpetuation of the free institutions that go to make the American way of life." Under our free enterprise system, ownership of real property has reached the widest distribution known in man's history. The stability of this ownership would have been greatly improved had we given more careful consideration to soils.

The real property of the Nation consists of land and improvements on land. Most businessmen, homeowners, or other dealers in real property have little trouble in properly assessing the value of the improvements on a tract of land. But it is surprising how many of them have largely ignored the actual value of the land itself, even though an up-to-date soil survey could be purchased for a few cents that would give them the basic information needed to properly evaluate the land.

Note:—The author is vice president of a prominent real estate firm in Washington, D.C.



Verlin W. Smith

From my experiences over the past 10 years, I am convinced that up-to-date soil surveys furnish information that is fully as important to rurban and suburban developments as it is to farmers. In some instances it can be much more important, because the value of the improvements to be placed on the land is so much greater. It seems to me that such surveys should be carefully studied by all planning commissions of every jurisdiction. And I find that many county and community planning commissions are using such surveys—are beginning to take a look at what is beneath the surface of the ground in making their plans for the future. Unfortunately, too many are not doing so.

I have found that some of the older soil surveys, especially those completed more than 25 or 30 years ago, do not give as much detailed information as might be desired by suburban or rurban planners. But even these older surveys furnish much basic information about soil types that is of considerable value in appraising farmland, and may have much value to the average rurbanite or suburbanite if he will get a soil scientist or other qualified person to interpret the information. And the newer surveys, especially those made during the past 5 or 10 years, give a wealth of information to almost anyone interested in ap-

praising land for almost any purpose, if he but takes the time and trouble to study the maps and the discussions on the characteristics and limitations of the various soil types.

Since all taxpayers contribute toward the cost of soil surveys, it was difficult to understand why the soil maps were locked in the county agent's desk drawer of one county in Virginia, when I sought to use them a few years ago. The agent in this county had worked many years to obtain a good survey and was an enthusiastic user of soils information. He had seen the "hammer fall" at many foreclosures, and seen numerous disappointed city farmers and others who had failed to investigate the soil when they purchased land. Yet, he told me that the soil maps could not be used by realtors unless they received written permission from the owners. The reason, as I recall, was that shortly after the soil survey was completed a prospective farm purchaser told a farmer that he would buy his farm if the soil was of as good quality as had been represented. This prospective purchaser checked the soil maps, which showed that the soils were inferior. When the deal failed to materialize, the property owner filed suit against the county agent and governing body. After this fiasco the soil maps became "restricted" information.

I found that owners of good soils in this county usually were willing to give written authority for a realtor to use the maps, but that persons who wished to sell inferior land were not so inclined. Many of the farms falling in the latter classification may be referred to as "hot farms" because they usually change hands frequently.

What appeared to be a difficult situation in this county led to the wisest investment I believe any realtor selling land can make. Through the Virginia Agricultural Experiment Station and U.S. Soil Conservation Service, the real estate firm with which I am associated was able to purchase complete sets of soil survey maps for most counties in which we transact business. Of all the maps and numerous other sales materials available, if I were limited to using just one item in the sale of land for either farming or urbanization, I'd prefer the soil map. The cost to one office or individual in acquiring such valuable information would be prohibitive; but since the maps are available at such a reasonable price, I know of no other way to buy the work of experts so cheaply.

I recently used two sheets of a soil survey map, which were made on 1937 aerial photos, for an appraisal of a farm. When I glanced at the photos while inspecting the farm, it was almost like waving a red flag at a bull. The prospective seller didn't like it a bit, because the soil maps immediately revealed why the cultivated fields had receded from the timberline during the past 20 years. The map showed stony, shallow land on D and E slopes (20 to 40 percent)—an impossible situation for mechanized equipment and $1-per-hour labor. This and other information were used to negotiate a purchase at a realistic price.

Our able and wide-awake county agent in Fairfax County, Va., was quick to recognize an opportunity to get a soil survey as part of a master zoning plan. Several years ago a planning consultant from New York told the county board that the outdated 1915 soil map was inadequate for proper planning, especially in locating flood plains. A recent consulting engineer's report bears out this contention. It states that 6.9 million dollars will be necessary to correct damages which occur to houses on only two of the several flood plains of the county.

The Board of Supervisors of Fairfax County, faced with a multitude of problems created by a population increase from 40,000 in 1940 to 100,000 in 1950 and estimates, since confirmed, of over 250,000 by 1960, contracted with the Soil Conservation Service and the Virginia Agricultural Experiment Station for an accurate and detailed soil survey. The county paid a substantial part of the cost to get the survey speeded up. It was three years in the making, and before completion the demands upon the soil survey party for soils information were so great that the survey was delayed several months. Since then the county has hired a full-time soil scientist to interpret the survey information. His services have saved the taxpayers millions of dollars.

After the soil survey was completed in Fairfax County, I had the misfortune of learning firsthand how adversely an accurate and detailed soil survey can affect real estate values, and also affect one's financial statement and ego. After I left the Marines at the end of World War II, my wife and I purchased 70 acres in this county, 21 miles from the White House, as a combination homestead and investment. We had planned eventually to sell homesites along the road frontage and were pleased to have an increasing number of inquiries for sites as urbanization moved closer. A study of the soils map, which incidentally is furnished free to anyone in the county, revealed that none of the soil near the road would pass percolation tests. Any homesites will have to be from 500 to 1,500 feet from the road and a stream, with an uncomfortably wide flood plain, will have to be bridged. This land today probably would bring $750 per acre, whereas better land with similar topography, road frontage, etc., would fetch $1,500 to $2,000 per acre. Needless to say, our next

land purchase will be based on what is underneath the surface.

During 14 years of handling the sale of farms and acreage, I have observed and heard of hundreds of instances where the use of soils information could have prevented serious and often expensive mistakes. A few follow:

A school board purchased 25 acres as a site for a high school at a cost of $20,000, designed the building, and let the contract for about 1.3 million dollars. The builder encountered poor footing conditions and renegotiated the contract for stabilizing the foundation. This cost was more than $230,000 above normal cost—enough money to pay for 3 soil surveys of the entire county, to hire a county soil scientist for 23 years at $10,000 per year, to build a much-needed eight-room elementary school, or to reduce the tax rate for the entire county by 10¢ per $100 assessment. A study of the soils on the site later showed that the building could have been constructed on solid ground a few hundred feet away.

A school board purchased a site and built a school on impermeable soil, and constructed a conventional septic tank and drainage field. When the drainage field failed, a sand filter was constructed. When the sand filter failed, a 4-inch ditching tile was run between the filter and a nearby stream.

A county floated a large bond issue to eliminate health hazards caused by 2,000 overflowing individual septic tank disposal systems.

The Federal Housing Administration refused to insure loans on approximately $2 million worth of homes under construction or built in one area because the soils were unsuitable for individual sewage disposal systems.

Three apartment buildings were abandoned and windows boarded over in one community because of serious cracks in walls and foundation—apparently the result of poor underlying soil.

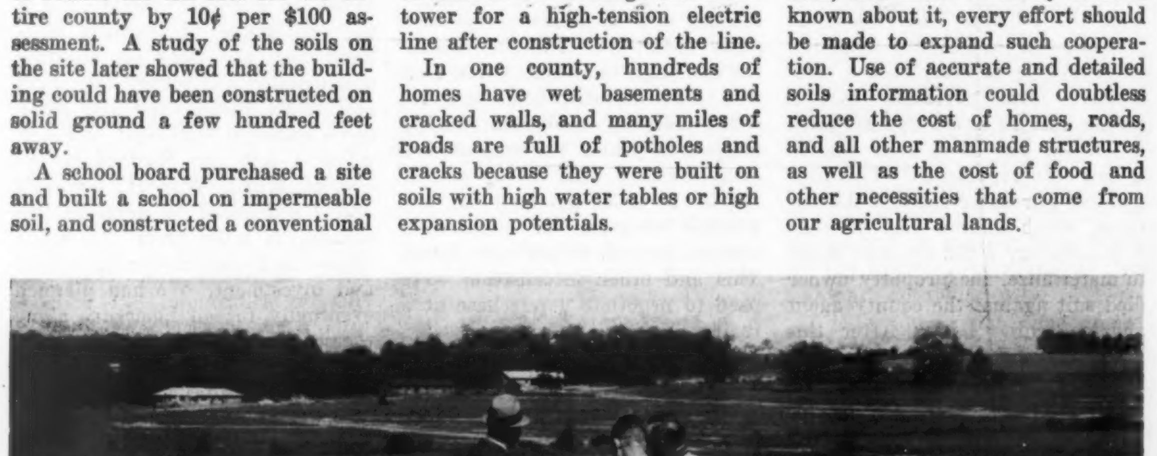
Approximately $7,000 was spent to stabilize the footings under one tower for a high-tension electric line after construction of the line.

In one county, hundreds of homes have wet basements and cracked walls, and many miles of roads are full of potholes and cracks because they were built on soils with high water tables or high expansion potentials.

Volumes of printed material are available on the 6-penny nail, a southern pine two-by-four, clay products, or almost any kind of building material you wish to mention. But pitifully little information is available on the building site potentials of the approximately 7,000 series of soil that have been identified, described, and mapped in the U. S.

The Federal Housing Administration, Soil Conservation Service, Virginia Polytechnic Institute, and Bureau of Public Roads are to be congratulated for their forward step in this respect by furnishing data for and publishing the F.H.A. Manual No. 373, titled "Engineering Soil Classification for Residential Developments."

Since soil is the most widely used building material and all improvements rest on it or parent rock, and since relatively little is known about it, every effort should be made to expand such cooperation. Use of accurate and detailed soils information could doubtless reduce the cost of homes, roads, and all other manmade structures, as well as the cost of food and other necessities that come from our agricultural lands.



A prospective buyer, seller, and realtor check the soil map for land involved in a suburban development.

They Learn About Their Soil Maps

By Reservation Only

By R. W. Eikleberry

THE farmers of Geary County, Kansas, have a modern soil map and soil survey report. They know how to use it, too.

Geary County is not very large; there are only about 500 farms in the county. But over 600 men, women, and children were on hand for the four meetings held in Geary County to receive their copy of the Soil Survey Report.

Mike Stroud, county agent in Geary County, organized the meetings; and Mike knows how to organize and carry on a meeting when he has something of benefit to his farmers. He doesn't just announce a meeting and put a notice in the papers. You have to have a reservation to come to his meetings or you don't attend.

The farmers know that when Mike has a meeting he has something that will help them. Every detail is planned in advance, and Mike doesn't do all the work, either. The 4-H Clubs, Home Demonstration Agent, County Farm Bureau, soil conservation district supervisors, the farmers and their wives all have a job to do; and they all did their job well at the meetings I attended.

When the meetings were scheduled, there were committees for food, water, and seating—they had portable bleachers—entertainment for the children, wood cutters, a public address system, and even portable rest rooms.

Willard Bidwell, professor of soils at Kansas State University, had prepared for these meetings in advance. The farmers and their wives and children didn't have to chase through tall corn, waist-high bluestem grass, or dusty stubble fields to look down into a hole at the soils. Willard brought the soils to the "meetin'" place. He had a mounted profile of each of the 19 main soils of the county. He used the profiles to explain soil mapping units, erosion, depth, texture, inherent fertility, and just how a soil scientist makes a soil map.

Elmer Betz, the SCS work unit conservationist, had prepared large soil and capability maps and land use maps to explain how a tailor-made farm or ranch plan is made to fit the farm and the farmer. He used the maps to explain land capabilities, range sites, and how the landowner chooses the practices to fit the land. He explained that he was there to help them choose, from a number of alternatives, how they could best use their land within its capabilities and treat it according to its needs. Elmer also had done some real advance planning. Over a year ago he had put out over 20 grass variety test plots on the Gaylord Munson farm. These were located just up the road from the meeting place in Mr. Munson's well-kept farmyard. Grass is a crop in Geary County. There are about 30,000 head of cattle here in an average year. So, the farmers want to know about the best kinds of grass and how to manage them for more pounds of beef—more dollars for their labor. Here on these test plots, Elmer showed them that some grasses were better on this particular soil than others.

I looked at my watch and thought it was getting late. It was nearly nine o'clock at night, and the meeting had started officially at six. I glanced around, but no one was leaving. Mike Stroud knew what he was doing. He introduced Bob Bohannon, Extension agronomist from Kansas State University. Bob did not really need an introduction. He had been there since one o'clock in the afternoon, and by this time he could call most of the farmers by their first name.

Bob didn't just talk to the men, either. As the women gathered here and sat on the edge of the bleachers, he talked woman-talk to them—money. How could they get that new stove, deep freeze, curtains, linoleum for the kitchen, or maybe a new dress to wear to church on Sunday? Would they be able to send that little boy or girl of theirs to Kansas State University? When he told them about more wheat in the bin, more hay in the stack, more corn in the crib, or more fat on a steer, they knew that he was talking their language.

Bob explained to them that crops were just like cattle and chickens. They each require a different diet. He showed them crops grown in the greenhouse on soils collected in Geary County. He explained how a balanced fertilizer program based on soil tests would increase their crops.

Note:—The author is correlator for soil interpretations, Soil Conservation Service, Lincoln, Nebr.

Bob had done some more planning, too. Back in May he had put out fertilizer demonstration plots on corn within 200 feet of the beautiful farmyard of Wayne Upham, the meeting place the first evening. Here the farmers and their wives and children could view the results from on-site demonstrations. Some of that corn will go over 100 bushels per acre—"dryland."

At 9:30 I thought surely some of them would slip off and go home; but they didn't. These people came to learn. Large tables were set up under the lights, and each family was given a soil survey report. The men in charge had trained some helpers to assist each family to locate and outline their

They came to eat, listen, look, and learn.

farm on the soil map. They showed them how to read the mapping units, find the soil descriptions, capability units, management and erosion control practices, and the adapted crops or range sites. Yes, even the farmer who had broken both legs the week before in a tractor accident and had to come in a wheel chair, knew how to use the soil survey report of Geary County.

The meeting was over by 9:45 on the Munson farm; but the people still didn't go home. They gathered around the agricultural workers who had come there to help them learn about their soils. They asked questions and gave opinions. By 10 o'clock, the bleachers, tables, water tank, soil profiles, barbeque pit, and portable rest rooms were on large grain trucks ready for transport to the Shirley Janke farm, 15 miles southwest. The show must go on. It would be a different group down in the Flint Hills part of the county tomorrow. There it would be mostly cattlemen with large ranches; but these ranchers know that they can't afford to stay at home; not when Mike Stroud and Elmer Betz invite them to come by reservation only.

Within the coming year, Kansas will have five more of these modern soil survey reports. You can be assured they won't be left in a storeroom to collect dust if Bohannon and Bidwell stay around. While it is only a one-time affair with the men in each county such as Mike Stroud and Elmer Betz, with Bohannon and Bidwell it will be five more stands and they will play to full houses of interested, hard-working farm families.

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During the past decade, the number of farm tractors in the world has increased by some 70 percent; in the same period, the horse population dropped 7 percent.

Building Soil With Grass

By Roe D. Crabtree

PLACE a carpet of prairie sod over the top of the Palouse hills. Give it centuries to develop a fertile soil layer. Break it out with a plow and cultivate it for 50 to 70 years and you have the present-day Palouse country farmland of eastern Washington.

In this relatively short period of cultivation, erosion has moved many tons of topsoil down the hills so that from a fourth to a half of the original topsoil is no longer in its proper place; the clay subsoil on the ridges and points of the hills is exposed.

The soil has lost much of its former "bounce" and needs to develop some of its former structure that has been broken down by tillage. It needs a chance to get back on its feet so it can continue to withstand the rigors of present-day use.

The Palouse soils are built on a deposition of silt up to 200 feet in thickness overlying the Columbia basalt flows. This deposition was blown from the dry basins to the southwest and heaped into hills which were elongated from the southwest to northeast and reshaped by running water and geologic erosion.

Larry Lothspeich, a conservation farmer and supervisor of the Central Whitman Soil Conservation District, is reconditioning some of his land by seeding alfalfa and grass. The hillsides were seeded to

Note:—The author is work unit conservationist, Soil Conservation Service, Colfax, Wash.

Larry Lothspeich examines the heavy stubble left from a 70-bushel wheat crop to decide how best to use it in his conservation farming program.

Greenar intermediate wheatgrass and alfalfa, uncut for 4 years, blanket the steep hillsides, while alfalfa and orchardgrass, cut for hay, cover the gentler slopes on the Lothspeich farm.

a mixture of four pounds of alfalfa and 12 pounds of Greenar intermediate wheatgrass per acre, which has gone unharvested for the past four years. The bottomlands have orchardgrass and alfalfa which is used for hay.

A 79-acre field was seeded about the time the current wheat allotment program went into effect. It includes some very steep slopes, clay ridge tops, "eyebrows," and also some relatively flat bottomland. This stand will be left in the grass legume cover for 5 or 6 years, at which time it will be broken out except for the very steep slopes.

Grasses and legumes play an important part in the restoration and maintenance of soil. They can be seeded alone or in mixtures, and utilized for forage, seed, erosion control, or soil improvement. This is especially true of the perennials that are allowed to grow for several years. A good stand protects the soil against erosion, builds soil structure, increases productivity, and improves the biological life.

Greenar intermediate wheatgrass is high in root production. By the end of four growing seasons at Pullman, Wash., Greenar had produced 7,424 pounds of root material in the top 8 inches of soil.

Greenar is a mild sod-former. It is easy to establish from spring plantings, has excellent seedling vigor, and gives a dense, leafy ground cover the first year. It makes a good mixture with alfalfa, reaching the hay stage at least two weeks later than alfalfa, making a better quality mixed hay. Greenar begins growth in early spring and reaches pasture readiness about the same time as alfalfa. It makes good growth in the early fall so that ground cover is maintained over winter.

The past cropping history for this part of the Palouse country has been black fallow and wheat, with barley, oats, or peas as secondary crops. This system of farming tends to decrease the organic matter level and increase the hazards of erosion.

The soil conservation districts in the Palouse country are working with the Soil Conservation Service and other agencies in developing alternative systems of land use that will maintain productivity and reduce erosion and at the same time be profitable. It has been found that cropping systems using alfalfa and grass in rotation with grain crops or continuous grain plus nitrogen with full utilization of crop residues are satisfactory for organic matter maintenance and erosion control.

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Weed control is important. Experimental results from experiment stations in the North Central States show that one plant of yellow mustard uses twice as much nitrogen, twice as much phosphorus, and four times as much water as a well-developed oat plant. A common ragweed uses three times as much water as a corn plant. One lambsquarter in a hill of corn reduces the yield by one-third. The earlier these weeds are killed, the less depressing the effect on the yield.

Of shoes, and ships, and sealing wax, and—

A Lot About Snow

By Tarleton A. Jenkins

AT a snow conference, folks talk about as great a variety of subjects as the walrus and the carpenter. All of them, of course, about snow.

Snowpack management, snow surveying, avalanche control, short-cutting the snow survey job, reducing evaporation—that's a sample of the topics.

At the Western Snow Conference in April 1960 at Santa Fe, N. Mex., the 100 or more delegates talked about all of these things and many others. They brought snow surveying up to date in the electronic age, going into the use of electric pulses to indicate snow depth, air temperature, snow quality, and soil moisture. They talked about the use of electronic computers to digest the thousands of reports and come up in minutes with the needed answers.

The delegates heard a group of U.S. Forest Service men report on what they have learned in trying to guide snow into the best places and to slow down, where needed, its melting rate.

In the group were Henry W. Anderson of Berkeley, Calif.; Marvin D. Hoover of Fort Collins, Colo.; Howard W. Lull of Upper Darby, Pa; and Paul E. Packer of Missoula, Mont. Serving as moderator was Irvin M. Ingerson of California's Department of Water Resources.

The four discussed the effects of the various kinds of forest management on snowpack, melt, and runoff. They told of the use of snow fences and of the effects of thinning or strip-cutting of timber stands on snow distribution.

Note:—The author is information specialist, Soil Conservation Service, Denver, Colo.

The variety of interests represented in the 28-year-old Western Snow Conference is reflected by these 15 delegates to the Santa Fe session. From left, they are: Dave Mathias, irrigator, Monte Vista, Colo.; David M. Rockwood, Army Corps of Engineers, Portland, Oreg.; Philip B. Mutz, Interstate Streams Compact, Santa Fe; Robert Bursiel, highway engineer, Girdwood, Alaska; George A. Lewis, City Water and Power Dept., Los Angeles, Calif.; Walter E. Johnson, Washington Power Co., Spokane, Wash.; Francis T. Mayo, State Engineering Dept., Bountiful, Utah; Manes Barton, Soil Conservation Service, Reno, Nev.; Bert Goodell, Forest Service, Fort Collins, Colo.; Wilbur L. Heckler, Geological Survey, Sante Fe; Lee M. Maxwell, University of Idaho, Moscow, Idaho; George W. Peak, Soil Conservation Service, Casper, Wyo.; H. I. Hunter, Department of Lands and Forests, British Columbia, Canada; and Walter U. Garstka, Bureau of Reclamation, Denver, Colo.

Lull, whose work has been in the mountainous areas of the Northeast, pointed out that the problems in his part of the country are related more to flood-inducing runoff than to water supply.

Packer explained that experience with a vast stand of lodgepole pine in the Northwest has furnished clues in the effect of cutting practices on water quality. There may be an opportunity under some conditions to manage the timber harvest to improve the quality of water for downstream users, he said. His area principally needs management to cause an earlier flow of water and a longer tapering-off period.

Wind characteristics at alpine levels of the western mountains are sometimes surprising, Hoover told his audience. "Snow fences often produce some weird and wonderful effects."

Induced avalanches to store snow in preferred gathering places and the use of artificial ridges are possibilities for the future management of snowpack, he reported.

Anderson discussed the behavior of snow under varying conditions —in the snow zone high up, in the forested areas lower down, in areas of brush, and in bare spaces. Removing brush sometimes gives substantial increases in water yields, he said.

Walter U. Garstka of Denver, chief of the Bureau of Reclamation chemical engineering laboratory branch, told the conference that the principles of "monolayer" treatment of reservoir surfaces are sound. A practical, low-cost way of reducing evaporation from reservoir surfaces isn't far off, he said.

The film, six ten-millionths of an inch or one molecule thick, has proved effective in reducing evaporation from large surfaces by nine percent. A 36-percent reduction is a practical mark to shoot at, Garstka maintained.

A Canadian, Peter A. Schaerer of the National Research Council, Ottawa, reported his nation's efforts to protect the new Trans-Canada Highway where it weaves through Rogers Pass. They have worked up case histories on the treacherous avalanche areas. They will build sheds for the worst, and treat the less troublesome ones with guards and barriers.

M. Martinelli, Jr., of the Rocky Mountain Forest and Experiment Station at Fort Collins, had a most attentive audience for his report on observations of avalanche control in Europe. The French have worked out an ingenious system of nylon nets and earth barriers.

Backdrop for the entire conference scene was the widespread use of water yield forecasting based on the State-Federal snow survey which is directed by the Soil Conservation Service. Throughout the three-day session, speakers referred frequently to its use, to improvements that may be possible in techniques. Arch Work, veteran Soil Conservation Service employee at Portland, Oreg., heads the water forecasting section. He has long been active in the snow conference.

The 1961 conference will be at Spokane, Wash., with Jerry Van de Erve of Sacramento, Calif., as general chairman. Van de Erve is area engineer for the U.S. Weather Bureau.

Francis T. Mayo (left), chairman of the snow conference, explains the work of a snow survey team to W. A. Williams, area vice president of NASCD.

Better Nitrogen Tests for Wisconsin Soils

Modifications in a soil testing procedure may lead to sharper recomendations for nitrogen fertilization, according to University of Wisconsin soil scientists. Basically, the new procedure is a modification of an older method for determining available nitrogen in soils. The main difference is that the new testing method also takes account of the nitrate form of nitrogen. The older procedure ignored this form of nitrogen, so probably underestimated the amount of available nitrogen in the soil.

Snow Survey Forecasts Make the Difference

Between Success and Failure

By Clarence Hedrick

AS early as January 1960, John Pastoor had a part of the story. By April—with planting time at hand—he had the rest: "Water for irrigating Pastoor's land will be only about half of what he normally receives." The story was not good news, but it did come in time for him to do something about it.

The word had come from the Cooperative Snow Survey, the annual winter-to-spring checkup by the Soil Conservation Service and participating agencies on mountain snow and its water content. From this survey, Pastoor and his neighbors—as well as cities, power companies, and other water users downstream—could know well in advance how much water they likely would have in the following months.

For John Pastoor and his neighbors, south of Twin Falls, Idaho, the word that the water supply for irrigation would be only half that of normal had this meaning:

They would fit their plantings to the water outlook. For Pastoor it meant that he would plant a portion of his irrigated acres—200 out of the 360 on his farm—to crops that needed less water than the potatoes and alfalfa that he otherwise might have grown.

Pastoor, widely respected in the Twin Falls Soil Conservation District as an irrigation farmer, has 687 shares of water. By using this water with top efficiency—letting a minimum get away in the irrigation process—he ordinarily has enough for his 200 acres under irrigation. He figures 2.5 acre-feet to the acre will give him a maximum yield. (It isn't uncommon in the West to find irrigation farmers using three times that much to get satisfactory crops.)

For Pastoor, getting along with less-than-normal water was not a new experience. It was much that way in the 1959 irrigation season. The April snow survey report that year showed the water yield would be only .34 acre-foot per share.

That much of a shortage did not necessarily mean a serious problem for Pastoor and his neighbors. It was mighty important, though, that they know in advance of planting time how much water they could expect.

In 1959 Pastoor, using the estimate of the irrigation supply, figured he would have 233 acre-feet of water for the season. Since he needs 2.5 acre-feet per acre for efficient cropping, he could then figure the acreage he could safely irrigate.

He actually prepared and seeded 103 acres, with 78 acres in wheat and 25 acres in peas. The rest of his land he put in hay and grass, which have relatively low water requirements.

Pastoor's 1959 estimate of his water needs could scarcely have been more accurate. After the final irrigation he had one acre-foot of water left.

By making sure that he would have the needed water for the wheat and peas, Pastoor had been able to make top use of fertilizer and the water actually available. The wheat yielded 80 to 90 bushels per acre (a splendid yield in any section of the country) and the peas yielded 30 sacks per acre.

John Pastoor in a field of Siberian wheatgrass that produced $200 worth of seed per acre.

Note:—The author is work unit conservationist, Soil Conservation Service, Twin Falls, Idaho.

The idle land on the Pastoor place got the treatment a conservation farmer like Pastoor would be expected to give it. He used a rod-weeder to keep down weeds and did some additional leveling and shortening irrigation runs. And he used his other spare time to improve his irrigation system still more by installing concrete pipelines.

Toward the end of the season Pastoor found he could put enough water on a planting of Siberian wheatgrass to get a seed crop. It grossed just over $200 an acre. This success led him to decide to put in 45 acres more of the wheatgrass for seed production and plant three acres of Alkar Tall wheatgrass.

In the Salmon Tract irrigation area, it wasn't hard to find examples of costly failures in the 1959 season. In some cases farmers, taking a chance on there being more water available than the forecast indicated, planted their usual acreages in crops requiring ample water. In some instances, there were stands of corn only half matured, potatoes that could not be profitably harvested, etc.

Pastoor's reliance on the accuracy of the snow forecast stems in part from his own efforts in gathering the survey information. With other farmers and ranchers in the district, he works with Walter Hankins of the Soil Conservation Service in making snow measurements throughout the winter. This work has helped him gain an understanding of how the information is processed and used.

There are some 25 other district supervisors and cooperators who have gone up the mountain to make snow surveys. The most consistent group are Supervisors Glen Nelson, Ellis Fuller, Ralph Schnell, and Truman Clark.

"They've been working on this runoff forecasting a long time now," Pastoor said. "The estimates we farmers get on the water outlook are worth a lot of money to us if we are willing to use them. I don't see how any farmer, given this information, can fail to take advantage of it. To me, it is just the difference between a successful farming year and a complete failure. It's not a hard choice for me to make."

Planning and planting in line with the water forecast made the difference between these fields of corn. (above) Victor Nelson in a field that received adequate water because some of the land on the farm lay fallow or was planted to grass. (below) A field on a neighboring farm where all the land was planted to crops that have high water requirements.

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Your soil is like a bank account. When you harvest a crop you remove plant food which must be replenished by decayed plants, insects, etc., or by commercial fertilizer.

IRRIGATING GRAIN SORGHUM FOR EFFICIENT WATER USE

By Jack T. Musick

There are nearly 3 million acres of irrigated grain sorghum in the western Great Plains. The primary source of irrigation water is pumping from underground reservoirs.

The western Great Plains has large acreages of nearly level land that can be prepared for irrigation at minimum cost. The water available for irrigation is limited, however, and should be used efficiently and conserved scrupulously to insure a continuous supply. In some areas, pumping has already exceeded natural recharge and has lowered water tables and underground storage.

An important question facing irrigation farmers of this region is when to irrigate to make the most efficient use of available water? A second important question is how many acres to irrigate? Intense irrigation of a small acreage will result in less efficient use of water. Likewise, spreading the water over too large an acreage may result in considerable reduction in yields and less efficient use of water.

An experiment was started in 1954 and continued through 1959 at the Garden City Branch Experiment Station in western Kansas, to study water management of irrigated grain sorghum. The control plots were irrigated four times, once before planting, at 10- to 14-inch plant height, at boot stage, and at milk stage of grain. This treatment, combined with optimum fertility and good management, approached maximum yields. Treatments were delayed or omitted on other plots to determine how limited irrigation affected plant development and grain yields.

The experiments were conducted on Ulysses clay loam, a typical "hardland" soil of the area. The soil has a deep, moderately permeable profile underlain with loess. Available water holding capacity is about 2.0 inches per foot of depth. The average annual precipitation is 17.98 inches but varies considerably from year to year.

The greatest cause of low grain yields is moisture stress. Low soil fertility, particularly nitrogen, is also a major cause of low yields on some soils.

Moisture stress which greatly decreased yields resulted in inefficient use of water for grain produc-

No. 59

This is the fifty-ninth of a series of articles to appear from time to time in explanation of the various phases of research being conducted by the Department of Agriculture on problems of soil and water conservation.

Grain sorghum grown with optimum irrigation. Plants at left received adequate nitrogen fertilizer, and produced about 62 percent more grain than plants at right, which received no nitrogen.

Note:—The author is agricultural engineer, Agricultural Research Service, Akron, Colo. (formerly at Garden City, Kansas).

tion. Water use efficiency is expressed as pounds of grain produced per acre-inch of water used by the crop. Under dryland production, the efficiency of water use usually ranges from 0 to 200 pounds per acre-inch. In this experimental study, use efficiency of irrigation water ranged from approximately 200 to 400 pounds per acre-inch.

The irrigation water requirement depends on the amount and distribution of rainfall and how fast the crop is growing. The daily rate of water use has a characteristic pattern throughout the growing season. Water use increased from less than 0.10 inch per day for young plants to slightly over 0.30 inch per day during the peak use period, from the time plants start to head until the grain has reached the milk stage.

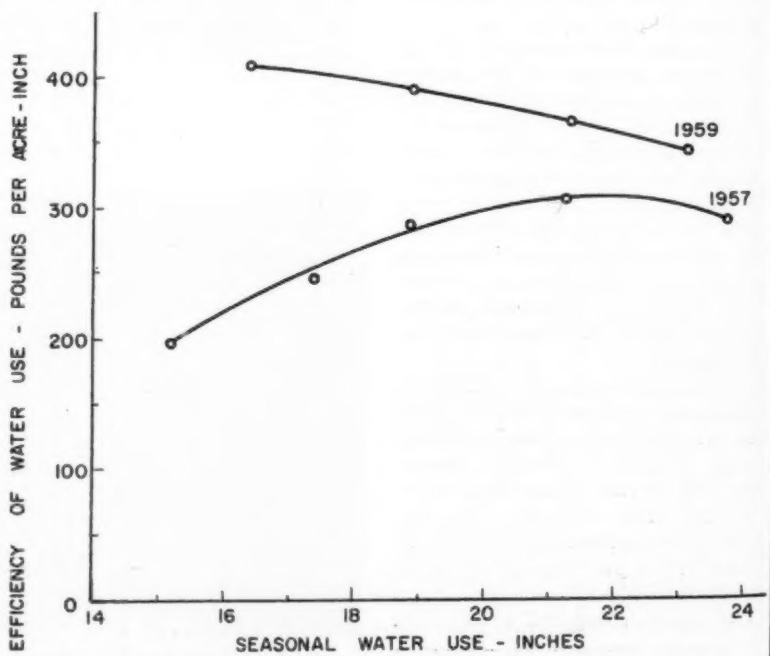
Irrigation increased grain yields in all years the experiments were carried on, but the increases varied considerably. The average yield for the 5 years was 4,100 pounds per acre from preplanting irrigation only and 6,500 pounds per acre for the maximum yield treatment. Dryland fallow yields during the same period averaged 1,800 pounds per acre. Thus, the maximum yields averaged 360 percent over dryland fallow yields.

Each successive irrigation increased yields less than the previous irrigation. Preplanting irrigation, that wet the soil to a depth of 6 feet, increased yields an average of 2,300 pounds per acre over dryland fallow. An additional irrigation at 10- to 14-inch plant height increased yields 1,610 pounds more per acre. A third irrigation at boot to early heading stage increased yields still another 600 pounds per acre. The last irrigation at milk to soft dough increased yields only 180 pounds per acre. A well-timed irrigation sometimes increased grain yields up to 3,000 pounds per acre and produced over 400 pounds of grain per acre-inch of additional water stored in the soil by irrigation.

There was considerable variation between total seasonal water use and efficiency of use in different years. For example, seasonal water use for maximum efficiency was about 20 to 22 inches in 1957 (see chart below). Four well-timed irrigations produced the highest efficiency of 305 pounds per acre-inch. But in 1959, the preplanting irrigation alone produced the highest efficiency of 407 pounds per acre-inch; and a seasonal water use of 16.4 inches was sufficient to mature the crop with only slight evidence of moisture stress. This stress decreased yields by only 1,220 pounds per acre, or 15.5 percent. In other words, the treatments which used the most water and produced maximum yields used water less efficiently for grain production.

During most years, near-maximum yields occurred for a total water use of 20 to 22 inches. Very little increase in yield occurred past 22 inches of water use. As the seasonal water use decreased below 20 inches, grain yields decreased at a faster rate. Other research in the Plains has indicated that from 8 to 10 inches of water must be available before plants will produce grain.

Two irrigations after planting usually resulted in near maximum yields. Where sorghum is planted in early June, the first irrigation may be applied in July and the second in August. Some conditions of soils, management, and weather may require more frequent irrigation. Coarser textured soils (sandy soils) which have lower water-holding capacities, shallow soils which limit rooting development and water storage, soils which are irrigated to shallow depths, and below-normal rainfall combined with hot, windy weather may



Relationship between seasonal water use and efficiency of water use for grain production, 1957 and 1959.

require 1 or 2 additional irrigations.

A limited water supply may be used efficiently by irrigating as many days during the year as possible. Off-season and preplanting irrigation can be practiced to spread the water over a larger acreage. Reasonably good yields can be obtained with only off-season or preplanting irrigation of deep soils. The soil should be wet to a depth of 5 to 7 feet. Yields from off-season or preplanting irrigation will vary considerably but will be more consistent than yields from dryland sorghum.

Other management and cultural practices are important to produce high yields. A fertility deficiency may greatly decrease yields and water use efficiency. Planting in narrow rows (7 to 14 inches) combined with optimum irrigation has increased grain yields. Adapted hybrids should be used. Weeds are a serious competitor for water and should be controlled. Water losses from ditches, field runoff, and deep percolation below the crop root zone should be minimized. Efficient use of water cannot be obtained from inefficient management or a poor water distribution system.

POWER TO PRODUCE: The Yearbook of Agriculture. 480 pp. Illus. 1960. Washington: U.S. Government Printing Office. $2.25.

MAN domesticated draft animals long before he learned to write and read. He discovered the principle of the wheel at the dawn of civilization, about 6,000 years ago. These things brought revolutionary changes in the power to produce on farms of the world. But with the exception of a few evolutionary developments, such as increasing the size of draft teams, the use of more pulleys and levers, etc., there were no substantial improvements in the farm power situation, until the invention of the steam tractor around the middle of the 19th century. Even then there was no great improvement in the power situation on the average farm. The modern revolution in power to produce on the farm did not really get under way until the 20th century. But during the past 50 years, and especially the past 25 years, the revolution in farm power has been phenomenal. That is the main theme of the 1960 Yearbook of the Department of Agriculture.

The book is divided into 9 main sections: Power in the Past; Power in the Present; Power on the Land; Power in the Harvest; Power and Livestock; Power in the Market; Power and Efficiency; Power and Its Effects; and Power in the Future. In each of these sections are several articles, written by specialists in the particular field, that give a wealth of detail and specific information. The book is indeed a wonderful reference work for anyone interested in past, present, or future power developments on the farms of America and other parts of the world.

Tractors get the main emphasis in this discussion of modern farm power; but other forms of power, including that supplied by trucks, stationary engines, and especially electricity, are also discussed with penetrating detail. The history of tractor development, from the cumbersome steam tractors of the 19th century to the specialized and all-purpose models of 1960, is given in interesting detail. The use of modern tractors with attachments for land shaping, ditching, plowing, cultivation, harvesting, and a multitude of other jobs gets full treatment.

The phenomena of rural electrification on 97 percent of American farms, mainly since 1935, is pointed up with many interesting details. The revolution in farm living and sanitary conditions, mainly the result of electricity and other forms of farm power, gets due attention.

The abolition or modification of many of the time-consuming and distasteful chores, once thought to be a necessary evil, is one of the bright parts of the power revolution. The automation of numerous jobs is one of the spectacular results. But the outstanding results in efficiency of production have been the phenomenal decrease in the amount of man-labor now required to do nearly all types of farm work and the fact that American farmers now can do many jobs, such as land shaping, that were considered impossible a few years ago.

The concluding section on "Power in the Future" envisions many interesting possibilities, such as further automation and improvements in farm buildings and living conditions.

The 96 pages of photographs (which are in addition to the 480 printed pages) show many interesting historical developments and illustrate many of our modern machines. There also are many explanatory drawings, diagrams, and charts. This book is a fitting sequel to the many other interesting and informative Yearbooks the Department of Agriculture has published since it started its specialized series in 1938.

—TOM DALE

Ohio Develops Better Soil Test

A new soil test developed by the Ohio Agricultural Experiment Station tells more accurately how much lime must be added to soil to reduce its acidity.

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The test is especially valuable when the soil contains large amounts of soluble aluminum. In such cases, the old test indicates that less lime is needed to raise the pH than is actually true.

The new test indicates more nearly the correct amount of lime regardless of the amount of soluble aluminum in the soil. It is now being used by the soil testing service of the Ohio State University.

As with the old test, it is a rapid test based on the amount of change in pH of a given amount of buffer by a given amount of soil. The new test makes use of a more dilute buffer mixture and a combination of buffers.

Aluminum, which composes 8 percent of the earth's crust, is not a new problem in Ohio. But soil scientists did not appreciate fully the impact of high amounts of aluminum on crops until plant studies designed to improve the lime requirement test were conducted. Due to the naturally high acidity of eastern Ohio soils, aluminum dissolves, making it easy for plants to absorb. Since the element is highly toxic, crops suffer.

Aluminum is further damaging because in a dissolved form it combines readily with soluble phosphorus, tying up this major crop element. If the stray aluminum supply is extremely high, eventually all phosphates may be recruited by the aluminum, leaving little phosphorus for crop use.

Maps to Show Subsoil Phosphorus and Potassium

Phosphorus and potassium fertilizer recommendations may someday be improved by a map which takes into account the amount of these elements in the subsoil, according to University of Wisconsin soil scientists. They envision a time, not too far away, when generalized maps will show the approximate amounts of these elements contained in the subsoils of various regions.

Since many farm crops can use a substantial part of the phosphorus and potassium in subsoils, the soil scientists think that fertilizer recommendations should consider the subsoil content as well as the topsoil content of these elements. Thus, a map showing the probable subsoil content could be used along with a soil test showing the topsoil content of one of these elements to arrive at more accurate estimates on the amount of fertilizer needed.

What Happens to Nitrogen Fertilizer?

A recent study by University of Illinois soil scientists showed that 2 years after application of commercial nitrogen the crops had used about 20 percent of the amount applied, 40 percent was still in the soil and presumably available for future crop use, about 10 percent had leached away, and 30 percent had vanished in other ways, mostly through the air by denitrification.

The scientists point out that these amounts may vary according to soil conditions and the form of nitrogen applied. They also admit that there is much more to be learned about the behavior of nitrogen in the soil. And they are continuing their work to learn more about the denitrification process and what happens to the nitrogen still in the soil that hasn't been used by plants.

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Tobacco breeding research designed to add root-knot nematode resistance to the fight against tobacco diseases showed encouraging progress in 1959.

Cooperative work underway by the Experiment Station and Crops Research Division, USDA, has resulted in two promising families of breeding lines. They combine high resistance to root knot and black shank.

In addition, these lines showed some resistance to fusarium wilt and Granville wilt. They also had considerable tolerance to brown spot in 1959.

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Soybean varieties resistant to the soybean cyst nematode, a pest that stunts plant growth and can cause total crop failure, are expected to be ready for growers with infested land in about four years, according to ARS of the Department of Agriculture.